GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Strength of Materials, PG_00055417		
Field of study	Mechatronics		
Date of commencement of studies	October 2022	Academic year of realisation of subject	2023/2024
Education level	first-cycle studies	Subject group	Obligatory subject group in the field of study Subject group related to scientific research in the field of study
Mode of study	Full-time studies	Mode of delivery	at the university
Year of study	2	Language of instruction	Polish
Semester of study	3	ECTS credits	6.0
Learning profile	general academic profile	Assessment form	exam
Conducting unit	Division of Mechatronics -> Institute of Mechanics and Machine Design -> Faculty of Mechanical Engineering and Ship Technology		
Name and surname of lecturer (lecturers)	Subject supervisor	prof. dr hab. inż. Krzysztof Kaliński	
	Teachers	mgr inż. Katarzyna Pytka mgr inż. Grzegorz Banaszek prof. dr hab. inż. Krzysztof Kaliński	

Lesson types and methods of instruction	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	30.0	30.0	15.0	0.0	0.0	75
	E-learning hours included: 0.0						

Learning activity and number of study hours	Learning activity	Participation in didactic classes included in study plan	Participation in consultation hours	Self-study	SUM
	Number of study hours	75	6.0	69.0	150

Subject objectives	The aim of the course is to familiarize students with methods applied in the area of strength of materials

Learning outcomes	Course outcome	Subject outcome	Method of verification
	[K6_U01] is able to acquire infromation form literature, databases and other, properly choosen sources, integrate these infomration, interpret them, draw conclusions and formulate opinions	The student has the ability to solve basic problems related to the strength of materials, including the performance of simple engineering tasks. The student has the ability to analyze basic issues related to the strength of materials in the field of theory and solving simple tasks and practical problems. This includes the topics mentioned in the subject purpose and later. The student has the ability to assess the usefulness of the presented content both from the point of view of designing technical objects and their operation in the broadly understood technology, energy and environmental protection.	[SU5] Assessment of ability to present the results of task [SU4] Assessment of ability to use methods and tools [SU3] Assessment of ability to use knowledge gained from the subject [SU2] Assessment of ability to analyse information [SU1] Assessment of task fulfilment
	[K6_W04] has organized and theoretically supported knowledge in terms of general mechanics, strength of materials, theory of mechanisms and machine dynamics, fluid dynamics, hydraulics and pneumatics, machine construction and engineering graphics	The student has the ability to analyze the basics of material strength, the compressive / tensile strength of a straight bar, strength analysis for statically indeterminate bar systems, torsional strength of bars, beam strength - bending, deformation of a bent beam, bar shear (shear bar), stress states, stress state and deformations, methods of determining stresses (shear forces, bending moments) and deformations for statically indeterminate bar systems, determination of elastic energy, stresses and deformations of bars and bar systems - energy methods, determination of elastic energy, stresses and deformations of beams and frames using the Maxwell method -Mohra, bar buckling, basics of the finite element method FEM. The student has the ability to model issues related to the strength of materials in the field of rigid bodies, biomechanics, mechanical systems, vibrations and basic mechanical structures.	[SW3] Assessment of knowledge contained in written work and projects [SW2] Assessment of knowledge contained in presentation [SW1] Assessment of factual knowledge
	[K6_U03] has self-learning skills	The student has the ability to analyze basic issues related to the strength of materials in the field of theory and solving simple tasks and practical problems. This applies to the topics mentioned in the purpose of the subject.	[SU5] Assessment of ability to present the results of task [SU4] Assessment of ability to use methods and tools [SU3] Assessment of ability to use knowledge gained from the subject [SU2] Assessment of ability to analyse information [SU1] Assessment of task fulfilment

<table>
<tr><td>Subject contents</td><td colspan="3">LECTURE. Basic terms of material strength: Modeling. Safety factor. Moments of inertia of plane figures. Compression and tension of bars: Equilibrium conditions and geometric conditions. Tensile and compression test. Hooke's law. Young's modulus. Poisson's ratio. Statically indeterminate problems. Torsion of bars. Bending of beams: Bending moments and transverse forces. Pure bending. Deformations and stresses in beams. Equation of the beam deflection axis. Boundary conditions. Clebsch's method. Effort of material: Hypothesis of specific energy of shear deformation. The maximum shear stress hypothesis. State of stress and strain: State of stress and deformation theory. Mohr circle. Statically indeterminate bar systems:. Boundary conditions method. Superposition method. Energy methods: Castigliano and Menabre's theorems. Maxwell-Mohr method. Calculation of trusses and frames. Bar stability: Buckling of compression bars. Bended beams stability. Basics of the finite element method:. Compression and tension of bars. General case of bar loads. TUTORIAL. Moments of inertia of plane figures. Compression and tension of bars. Statically indeterminate problems. Thermal and assembly deformations. Torsion of solid bars. Bending beams. Determination of internal forces and stresses in bars (dimensioning). Plane state of stress. Mohr's circle for a plane stress state. Principal stresses and maximum shear stresses. Ist colloquium. Complex strength issues. Castigliano's theorem. Menabrea-Castigliano theorem. Method of Maxwell-Mohr. Energy methods in statically indeterminate systems. Bar stability (buckling). 2nd Colloquium. Supplementary colloquium. LABORATORY. Static tensile test i static compression test of metals. Tensile test of metals: determination of the modulus of elasticity, conventional elasticity limit Rr0.05 (R0.05) and conventional yield point Rr0.2 (R0.2). Hardness test metals. Torsion test of metals and determination of the modulus of shear elasticity. Bending beam deflection test. Impact test of metals. Impact tensile test of metals.</td></tr>
<tr><td>Prerequisites
and co-requisites</td><td colspan="3">The student should have basic information in the field of applied physics and mathematics, mathematical analysis, numerical methods, solid state mechanics, including kinematics and dynamics, technical drawing and the basics of programming.</td></tr>
<tr><td rowspan="4">Assessment methods
and criteria</td><td>Subject passing criteria</td><td>Passing threshold</td><td>Percentage of the final grade</td></tr>
<tr><td>Lectures passing</td><td>50.0%</td><td>60.0%</td></tr>
<tr><td>Labs passing</td><td>50.0%</td><td>20.0%</td></tr>
<tr><td>Tutorials passing</td><td>50.0%</td><td>20.0%</td></tr>
<tr><td rowspan="3">Recommended reading</td><td>Basic literature</td><td colspan="2">1. Bąk R., Burczyński T.: Strength of materials with computer-aided elements. Warszawa: WNT 2001.
2. Dyląg Z., Jakubowicz A., Orłoś Z.: Strength of materials. Warszawa: WNT 1996 (t. I), 1997 (t. II).
3. Misiak J.: Applied mechanics. Statics and strength of materials. Warszawa: WNT 1996.
4. Kaliński K. J.: Supervision of dynamic processes in mechanical systems. Gdańsk: Wydaw. PG 2012.
5. Wojnicz W., Wittbrodt E.: Mechanical methods of testing materials. Laboratory exercises. Gdańsk: Wydaw. PG 2020.</td></tr>
<tr><td>Supplementary literature</td><td colspan="2">1. Niezgodziński M.E., Niezgodziński T.: Formulas, charts and strength tables. Warszawa: WNT 1996.
2. Walczyk Z.: Strength of materials. Gdańsk: Wyd. PG 2000 (t. I), 2001 (t. II).
3. Piechnik S.: Thin-walled open bars. Kraków: Wyd. PK 2008.</td></tr>
<tr><td>eResources addresses</td><td colspan="2">Adresy na platformie eNauczanie:
Wytrzymałość materialów, W, MTR, Ist, sem. 03, zima, 2023/24, (PG_00055417) - Moodle ID: 33277
https://enauczanie.pg.edu.pl/moodle/course/view.php?id=33277
Wytrzymałość materiałów, C, Mechatronika, sem.03, zimowy 23/24, stacjonarne (PG_00055417) - Moodle ID: 34376
https://enauczanie.pg.edu.pl/moodle/course/view.php?id=34376</td></tr>
</table>

Example issues/ example questions/ tasks being completed	**Theory** 1. Bar compressed/tensioned by continuous load. 2. Torsion of a straight bar with a circular cross-section. Equilibrium conditions, geometric conditions and physical relationships. 3. Material effort. Hypothesis of specific energy of shear strain. 4. Elastic energy of bar systems. Bending and shear bars. 5. Elastic buckling of straight bars. Eulerian cases. **Problems** 1. A hollow steel bar with an external diameter D_2, fixed at both ends, is loaded with a moment *M* at a distance of 0.5*L* from the right end. Plot the torques, maximum shear stresses and torsion angle. Given: *M* [Nm], *G* [Pa], D_1[m], D_2 [m], *L* [m]. 2. A uniform beam with a circular cross-section, placed on supports A and B, was loaded as shown in the drawing. Given: *q*, *a*, k_g, k_t. Draw plots of bending moments and transverse (shear) forces. Determine the dimension d of the beam taking into account the condition of permissible normal bending stresses and the condition of permissible shear stresses during bending. 3. A beam of length *l* and stiffness *EI*, fixed at one end and pinned at the other end, is loaded with a pair of forces *M* and a uniformly distributed load *q* acting over length l. Determine the angle of rotation of the beam at half of its length, using the Castigliano theorem and the Menabrei-Castigliano principle.
Work placement	Not applicable

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